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(71) Applicant: Nokia Corporation
02150 Espoo (FI)

(72) Inventors:
- Kallio, Jarno
  20200 Turku (FI)
- Virtanen, Kari
  20540 Turku (FI)

(74) Representative: Walaski, Jan Filip et al
Venner, Shipley & Co,
20 Little Britain
London EC1A 7DH (GB)

(54) Transmission burst time indications for power saving

(57) A method and apparatus are disclosed whereby a time-slicing approach to the delivery of packet data is enabled. The approach is particularly suited to enabling power management by mobile terminals where receiver demands otherwise place strenuous requirements on an internal power source such as a battery.

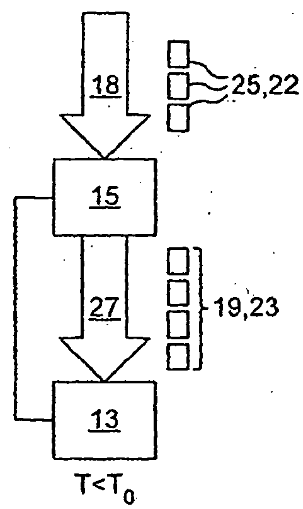

FIG. 4a

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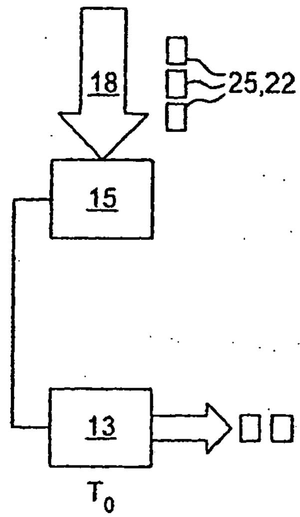

FIG. 4b

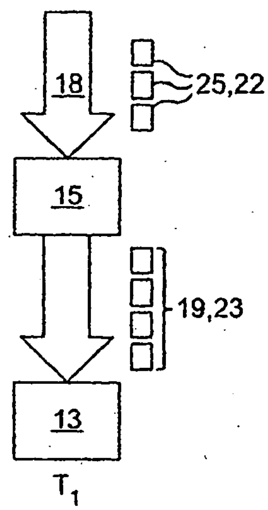

FIG. 4c

Description

[0001] The present invention relates to the content delivery utilising Internet Protocol (IP) networking, particularly, although not exclusively data networks.

[0002] Wireless IP networks, and particularly mobile wireless IP networks typically include a terminal having stringent power requirements. Such a mobile terminal may be required to operate for lengthy periods on an internal source of power. In the case of simplex wireless IP networks exemplified by the Digital Video Broadcast (DVB) terrestrial (DVB-T) and satellite (DVB-S) networks, typically a large part of the energy requirement of a terminal is due to the demands of a receiver necessary to receive transmissions carrying a range of content.

[0003] It is the case, however, that a user of the terminal may at an application level, as set out in the well-known Open System Interconnect (OSI) model, make a selection of particular content from the range of content presently received by the terminal. Although such a selection may take place in a unicast environment, that is a one to one transmission, more typically the content is distributed in a one to many transmission, that is a multicast environment.

[0004] A well-known mechanism for facilitating the delivery of content in a multicast environment is provided by the Session Announcement Protocol (SAP), details of which are set out in RFC2974 published by the Internet Engineering Task Force (IETF repository at http://www.ietf.org) and the Session Description Protocol (SDP), details of which are to be found in RFC2327 published by the Internet Engineering Task Force (IETF repository at http://www.ietf.org). In summary, an Application Programming Interface (API) is provided which facilitates communication between applications over an IP protocol. The API listens at a particular address for information identifying available streams of content, so-called services. The information provided at that address is then provided to an application, a browser for example, which in turn uses the API to access a selected stream by opening a socket at which the selected stream can be heard. Typically, the selection of the desired content is made by a user via the browser, i.e. by clicking on a particular link.

[0005] According to a first aspect of the present invention, there is provided a packet data transmission method, the method comprising receiving a content stream containing packets and dividing said packets into a sequence of sets of packets and for each set of packets in said sequence generating a transmission burst, wherein a field in each packet of a set includes a value indicative of a time offset to the generation of a further transmission burst containing a next set of packets in the sequence.

[0006] Such a transmission method facilitates a time-slicing approach to the delivery of packet data over IP networks, particularly wireless networks such as those now being utilised for the delivery of digital television and the like. Such a method is particularly suited to the delivery of data including multimedia content to mobile clients or terminal over such networks. Preferably, the method allows a head-end to receive multiple streams of content or services and thereby take advantage of the broad bandwidth and high data rates of such networks. The method is particularly suitable for use with the IPv6 protocol which is intended to include within the standard header space fields such as a flow_label field suitable for providing the timing and optionally grouping information for a burst. Each burst will contain sufficient information to allow it to be recognised by a receiving client (hereinafter a terminal). Typically, the identification is provided by an IP address and a flow_label value containing at least the time offset. It will be recognised that some information pointing towards the IP address or some other identifier may be added to the flow_label value so as to identifier a packet and in particular to allow it to be associated with a particular content or service stream.

[0007] Preferably, the method is applied to the delivery of data over a simplex broadcast network such as a broadband digital broadcast network. The method may be carried out entirely within the network head-end, in which case the generation of a value of the time offset may be carried out entirely within parameters set by the network operator. Alternatively, the content provider may apply the method to content before delivery of a content stream to the head-end of the transmission network.

[0008] Preferably, the method allows the re-transmission of packets in so-called copy bursts, that is bursts containing substantially the same packets as originally transmitted, so-called original bursts. In this transmission environment, the offset time held in packets of copy bursts will decrease as the burst generation time of the next original burst approaches.

[0009] According to a further aspect of the invention, there is provided a packet data reception method, the method comprising receiving a plurality of transmission bursts, extracting a set of packets from each burst, each packet including a first field having a value indicative of a sequence of sets of packets and a second field indicative of a time offset to the generation of a transmission burst containing a next set of packets in the sequence, analysing each of said extracted packets and identifying firstly a packet where a change in said first field to a predetermined value is detected and storing this and any subsequent packet with the same first field until such time as a further change in said first field value is detected whereupon reception of transmission bursts is suspended for the time offset identified from said second field value.

[0010] The reception method facilitates the delivery of multiple services or content for consumption by a terminal. The method seeks to facilitate robust error correction in that conveniently additional copy bursts may be

received to allow replacement of erroneous packets. In addition, the burst nature of the transmission method coupled with the timing information regarding the delivery of original bursts permits power management of the terminal functions. Thus, power intensive features of the terminal such as the broadband receiver circuitry may be powered down during periods where no burst is expected. Other power saving opportunities provided by the method include suspending processing requirements related to the identification of burst boundaries, a burst boundary being the change in the IP address or other sequence identifier between packets delivered in a stream as extracted from received bursts.

[0011] It should be noted that either of the above two aspects of the invention may be implemented as software, hardware, or a combination of the two, as would be apparent to those skilled in the art.

[0012] In order to assist in understanding the invention, an embodiment thereof will be described by way of example and with reference to the accompanying drawings, in which:

Figure 1, is a diagram illustrative of a transmission method in accordance with a first aspect of the present invention;

Figure 2, is a diagram showing in more detail a transmission channel of the method of Figure 1;

Figure 3, is a diagrammatic view of a terminal operable in accordance with a method of reception according to a second aspect of the present invention, shown receiving the transmission channel of Figure 2;

Figures 4a, 4b and 4c, are views illustrative of packet flows in the terminal of Figure 3; and

Figure 5, is a flow chart useful in understanding the reception method of Figure 3.

[0013] Referring to Figure 1, there is shown a broadband digital broadcast head-end 1 connected to a variety of sources 2, 3, 4 of content **A, B, C** which content or service is delivered to the head-end in the form of packets 5 of data, these packets having been generated in accordance with Version 6 of the Internet Protocol (IPv6) details of which may be found in RFC260 published by the Internet Engineering Task Force (IETF) and available at www.ietf.org. Thus, each packet includes a flow_label field to facilitate the handling by the Internet infrastructure of particular so-called flows of related packets. The flow_label itself forms part of the IPv6 header and is a 20bit field having a default value of zero. Further details of the flow_label as originally proposed may be found in RFC 2460 published by the IETF and available at www.ietf.org. Each source of content **A, B, C** is encapsulated by a packet data processor 6 at the head end 1 and placed into a transport stream 7 where it is multiplexed with the other content similarly encapsulated at the head-end 1 by the packet data processor 6. As will be described in more detail below, multicast and possibly unicast may include a non-zero flow_label field within the IPv6 header. The transport stream 7 further includes packets 9 providing time stamp information and control data identifying content in the stream 7. Other mechanisms for placing content into the transport stream 7 include, data piping, data streaming, and the use of data and object carousel. Such mechanisms are known, in the case of digital broadcast television, for example, from the Digital Video Broadcast (DVB) Project which describes one particular broadband digital broadcast solution using MPEG-2 to which the invention is applicable.

[0014] The content can include the delivery of Internet services via the transmission channel 18. Such services may be unicast, in the sense that they are a one to one provision of content or multicast in the sense that they are a one to many provision of content. In IP terms, a multicast address is differentiated from a unicast address by inspecting the most significant byte. A particular block of IP addresses are dedicated to use by multicast services namely 224.0.0.0 to 239.255.254.0 using the dotted decimal notation known from IPv4. In the case of IPv6, further details of which may be found from RFC2375 published by the IETF and available for the time being from www.ietf.org), multicast addresses are in the format FFAB where FF is the multicast identifier, A indicates whether the address is permanent or temporary and B provides the scope of the address. Thus, where a service is intended to be multicast, the service must ensure that an address from this block is utilised in the destination address portion of each IP packet.

[0015] Returning to the operation of the head-end 1, the packet data processor 6 having received the streams **A, B, C** of data corresponding to content or a service 2,3,4 divides each stream of packets into a sequence of discrete sets of packets for transmission at a selected time. The sets of packets 19 which have been divided in this manner are passed to a burst generator 20 which generates a high-bandwidth low-duration original burst 22 for transmission by a transmitter portion 21 of the head-end 1. Each original burst 22 contains data from a single IP address corresponding to the content or a service 2,3,4. The packet data processor 6 is further operable to generate a copy 23 of a set of packets which together make up a particular original burst 22 when so instructed by a controller 24. Again, copy set of packets 23 contains data from a single IP address corresponding to the content or service 2,3,4. This copy 23 of a set of packets is then passed to the burst generator 20 which, as before, generates a high-bandwidth low-duration burst for re-transmission as a copy burst 25 by the transmitter portion 21 of the head end 1. The copy bursts 25 are also transmitted at selected times which times are arranged such that bursts, whether an original or a copy and containing packets from a particular stream of data corresponding to content or service 2,3,4 do not collide either with another burst containing packets in that stream or another stream currently being transmitted by

the head-end 1.

[0016] With reference to Figure 2, in order to facilitate reception of a particular service or content 2,3,4 in such a transmission channel 18 where multiple bursts containing the same packets are transmitted, namely an original burst 22 and one or more copy bursts 25, in addition to dividing each packet stream into a sequence of discrete sets of packets, the packet data processor 6 also introduces a non-zero value into a flow_label field of every packet in each set which ultimately comprise a burst, whether an original or a copy burst 22,25. The value introduced into the flow_label field of each packet in a set from which a burst is formed, is a time offset 26 which provides the time interval from the start of the burst which includes that packet to the start of the next original burst in the sequence of bursts making up that particular content or service. Where a service is discontinued, there will be no further bursts having the same IP address, at least until a pre-determined timeout or guard interval has expired before a new service may start from that address. In this situation, the offset will be set to a maximum value or another predetermined value indicative of the service being discontinued.

[0017] The channel 18 is received by a set of terminals which in the case of a satellite system fall under the satellite footprint, whilst in the case of a terrestrial system, the receiving terminals fall within areas of transmission coverage of a transmitter network. Each terminal, which includes a mobile terminal 10, is typically under the control of a user at least as far as she is able to select particular content from that currently being transmitted in the transport stream 7. The mobile terminal 10 shown in Figure 3, includes an internal power supply 12, such as a rechargeable battery supplying power to a controller 13, user interface 14 and a receiver 15. The terminal 10 also incorporates both memory 16 and storage 17 necessary to execute applications and consume content. A fixed terminal may, of course, dispense with the requirement for a internal source of power.

[0018] The receiver 15, as has been mentioned, has a proportionally larger power consumption than the other components of the terminal 10. In order to minimise drain on the internal power supply 12, the receiver 15 may be switched on and off in response to instructions received from the controller 13. The receiver 15 , when in operation, receives the channel 18 over the air, in the case of satellite or terrestrial transmission. The operation of the receiver 15 is such that over a predetermined and possibly variable service period, say 60 seconds, the receiver 15 is capable of being switched into operation for one or more periods of time determined by the accuracy of a receiver clock forming part of the controller 13. For example, where the receiver clock accuracy can be maintained at 234 milliseconds, each period may last for 234.375 milliseconds there being 256 such periods within the aforementioned 60 second service period.

[0019] The controller 13 is operable to switch the receiver 15 between on and off states in response to the offset determined from the flow_label field as further described below with additional reference to Figures 4 and 5.

[0020] Thus, the receiver 15 is operable to receive bursts transmitted by the head-end 1. Of course, the head-end 1 will be transmitting bursts corresponding to a range of services and content 2,3,4. The receiver 15 extracts packets from each burst 22,25 it receives and the resulting sets of packets 19,23 are placed into a stream 27 which is analysed by the controller 13. The controller 13 analyses packets 22,25 in the stream 27 by determining the IP address and flow_label field values from the header of each packet. The controller 13 seeks 100 to identify a change from one IP multicast address to another IP multicast address which corresponds to content or a service which the terminal 10 wishes to consume. A change in IP address identifies a burst boundary, that is the beginning of a set of packets in the stream 27, which have been placed in the same burst 19,23 at the head-end 1.

[0021] Thus, where a boundary is identified 101, the controller determines whether the IP address of the another IP multicast address corresponds to an address of content or a service to be consumed by the terminal 10. If the another IP multicast address does indeed correspond then the controller, having identified such a boundary, further determines the flow_label field value in each packet header. This value will remain constant for each packet forming part of the same burst because it is a value indicative of the time offset 26 to the next original burst in the sequence of bursts making up that particular service 2,3,4. The controller 13 thereafter stores each packet it identifies as having the same IP address and offset value 26. It will be recognised that the duration of each burst 22,25 (although not shown as such on Figure 2 in particular) may be varied and correspondingly the number of packets contained in a burst need not be constant as the controller 13 will only stop storing packets from a burst once a change is detected in the IP address and/or flow_label value. Once such a change has been detected, the controller 13 initiates an error check 103 of the stored packets. Depending on the outcome of this error check the controller will take one of two steps. Where errors are detected, the controller marks those packets containing errors and continues to analyse the stream of packets 27 being extracted by the receiver 15 for a burst boundary indicative of a copy burst 25 corresponding to the burst 22,25 which delivered the packets presently in storage, namely the controller again seeks to identify a burst having the same IP address but note that the time offset 26 will be reduced. Providing such a burst exists and is detected by the controller 13, the controller 13 will store the packets from the copy burst and carry out an error analysis before replacing any bad packets in the first received burst with packets from the copy burst. Such a process will be repeated until the time-offset 26 has expired in which case a new original burst having the same IP address

should be detected unless the service is discontinued.

[0022] In a second non-illustrated variant, rather than replace individual packets, the entire set of packets from the first burst is discarded and replaced by the packets extracted from a copy burst. This process will be repeated until either all packet errors have been corrected or the next original burst in the sequence is received by the terminal in which case the packets from the last original burst may either be flushed from storage or passed with or without the marked up bad packets to a terminal application for consumption.

[0023] Where all the packet errors have been corrected or alternatively the time offset is about to expire, then the process moves to the second outcome namely the process followed where the error check 103 of the stored packets reveals no errors. Thus, the packets are marked as valid by the controller 13 and are passed for consumption at the application level by the terminal 10. However it is conceivable that in some circumstances, it may not be desirable to forward partial bursts, that is bursts containing some errors, for consumption by the terminal. In which case, the controller will simply drop the partial burst. At the same time, the controller 13 instructs the receiver 15 to shut down such that no more packets are extracted from incoming bursts 22,25 in the channel 18 with the result shown in Figure 4b that no packet stream 27 is delivered to the controller 13. The controller 13 however remains active and ready to instruct the receiver 15 to power up in anticipation of receiving (Figure 4c) the next original burst 22 in the sequence of bursts making up the particular content or service 2,3,4. The time period for which the receiver is shut down is determined, of course, from the flow_label field value namely the offset 26 derived from those valid packets extracted from the current burst. The controller 13 utilises the offset 26 to determine the time at which the receiver should be powered up ready to receive the next original burst in the sequence of packets making up the content or service. It may well be the case that the receiver 15 should be powered up some time in advance of the expiry of the time offset period to ensure that packets can be reliably extracted from the incoming channel 18.

[0024] By way of further explanation, where consumption of different content is desired, the controller 13 is simply provided with the IP address of the content or service 2,3,4 which is now desired. As will be apparent from Figure 4c in particular, the receiver 15 will be extracting packets from a number of bursts 22,25 containing packets of several content or service streams A, B,C delivered to the head-end 1 from their respective sources 2,3,4. It may well also be the case that the receiver 15 is powered off as a consequence of the last offset value 26 derived by the controller 13. In this event, the controller 13 may immediately power up the receiver 15 following the receipt of instructions to consume a new service or content. Alternatively, the receiver 15 may remain powered down until the time at which the controller causes it to power up to commence receiving the next original burst of what was the previously desired content. In this case, the controller will, rather than identify and store packets corresponding to the previously desired content, instead continue analysing the packet flow until a burst boundary is detected for a burst 22,25 containing the newly selected content or service packets 19,23.

Claims

1. A packet data transmission method, the method comprising receiving a content in the form of packets and dividing said packets into a sequence of sets of packets and for each set of packets in said sequence generating a transmission burst, wherein a field in each packet of a set includes a value indicative of a time offset to the generation of a further transmission burst containing a next set of packets in the sequence.

2. A method as claimed in Claim 1, wherein the sequence is such that sets of packets are generated as transmission bursts in the order that they are received in the content stream.

3. A method as claimed in Claim 1 or Claim 2, wherein separate sequences of sets of packets are generated as transmission bursts for respective ones of a plurality of received content streams.

4. A method as claimed in any one of Claims 1 to 3, wherein said field additionally contains a value indicative of a sequence of sets of packets.

5. A method as claimed in any one of Claims 1 to 3, wherein said packet includes a field having a value indicative of a sequence of sets of packets.

6. A method as claimed in Claim 4 or Claim 5, wherein said value indicative of a sequence of sets of packets is a multicast address.

7. A method as claimed in any one of Claims 1 to 6, wherein the time offset value of a packet is calculated utilising a transmission generation time of the burst which includes that packet and the transmission generation start time of the transmission burst containing the next set of packets in the sequence.

8. A method as claimed in any one of Claims 1 to 7, wherein the packets are received in a content stream.

9. A computer program comprising executable code for execution when loaded on a computer, wherein the computer is operable in accordance with said

code to carry out the method according to any one of Claims 1 to 8.

10. A program as claimed in Claim 9, stored in a computer readable medium.

11. A head-end apparatus for packet data transmission, wherein the apparatus is operable in accordance with any one of Claims 1 to 8.

12. A packet data reception method, the method comprising receiving a plurality of transmission bursts, extracting a set of packets from each burst, each packet including a first field having a value indicative of a sequence of sets of packets and a second field indicative of a time offset to the generation of a transmission burst containing a next set of packets in the sequence, analysing each of said extracted packets and identifying firstly a packet where a change in said first field to a predetermined value is detected and storing this and any subsequent packet with the same first field until such time as a further change in said first field value is detected whereupon reception of transmission bursts is suspended for the time offset identified from said second field value.

13. A method as claimed in Claim 12, wherein the suspension of reception is conditional upon the detection of no errors in the stored packets such that where an error exists in said stored packets, the analysis of said extracted packets is continued for packets having a first field corresponding to said predetermined value.

14. A method as claimed in Claim 13, wherein said stored packets are replaced by one or more packets obtained from said continued analysis.

15. A method as claimed in any one of Claims 12 to 14, wherein at least one of the following steps of extraction, analysis and storage is suspended together with said reception during said time offset.

16. A method as claimed in any one of Claims12 to 15, wherein said field value indicative of a sequence of sets of packets is a multicast address.

17. A method as claimed in any one of Claims 12 to 16, wherein the time offset value of a packet corresponds to the time difference calculated from a transmission generation time of the burst which includes that packet and the transmission generation start time of the transmission burst containing the next set of packets in the sequence.

18. A computer program comprising executable code for execution when loaded on a computer, wherein the computer is operable in accordance with said code to carry out the method according to any one of Claims 12 to 17.

19. A program as claimed in Claim 18, stored in a computer readable medium.

20. A terminal for packet data reception, wherein the apparatus is operable in accordance with any one of Claims 12 to 19.

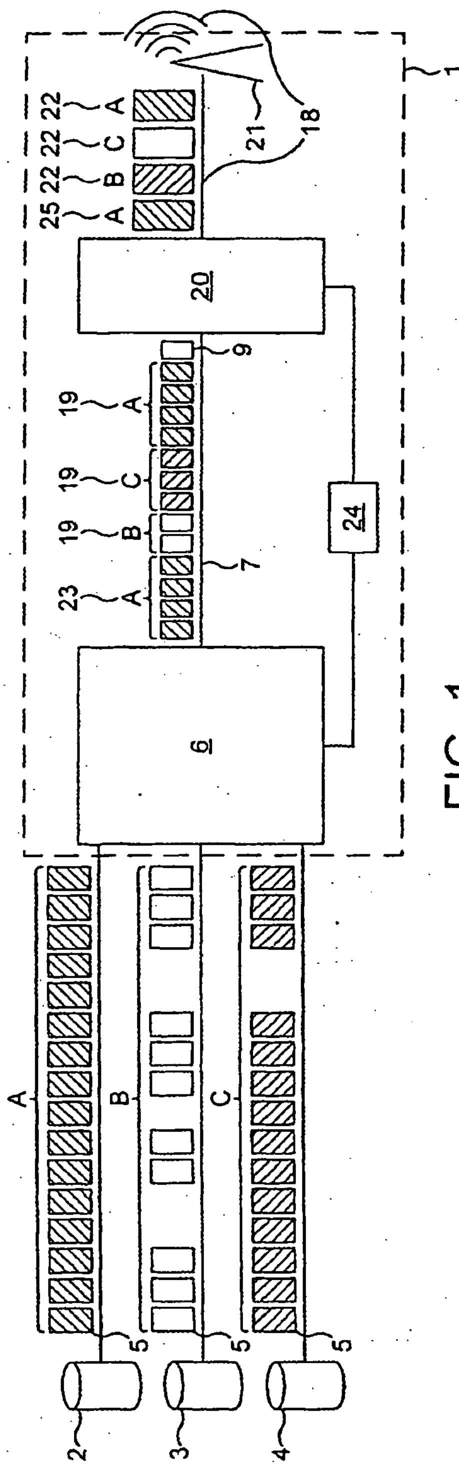

FIG. 1

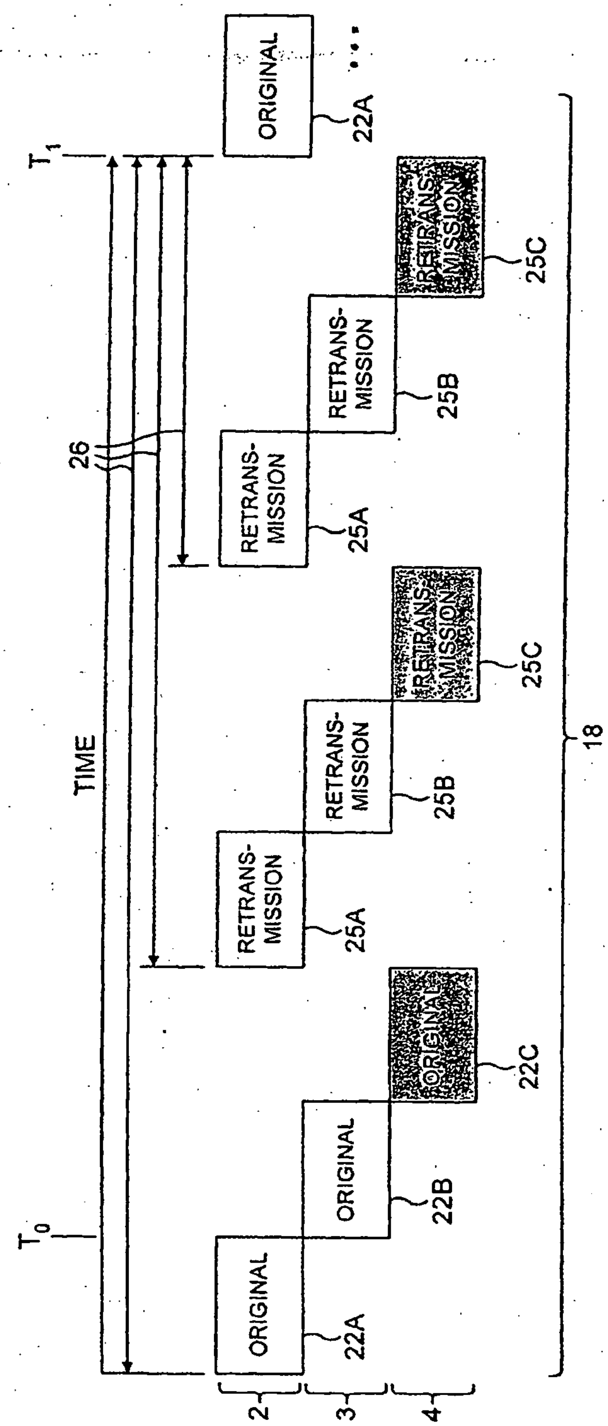
TIME
T_0
T_1
26
ORIGINAL
22A
ORIGINAL
22B
ORIGINAL
22C
RETRANS-MISSION
25A
RETRANS-MISSION
25B
RETRANS-MISSION
25C
RETRANS-MISSION
25A
RETRANS-MISSION
25B
RETRANS-MISSION
25C
ORIGINAL
22A
2
3
4
18

FIG. 2

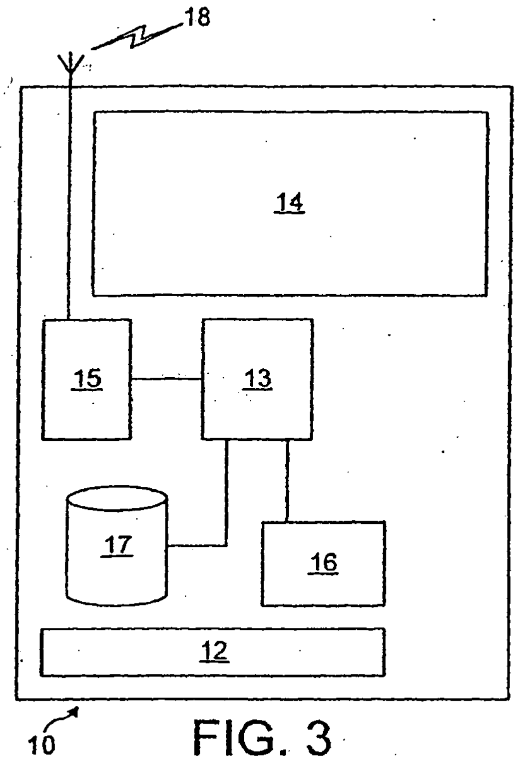

FIG. 3

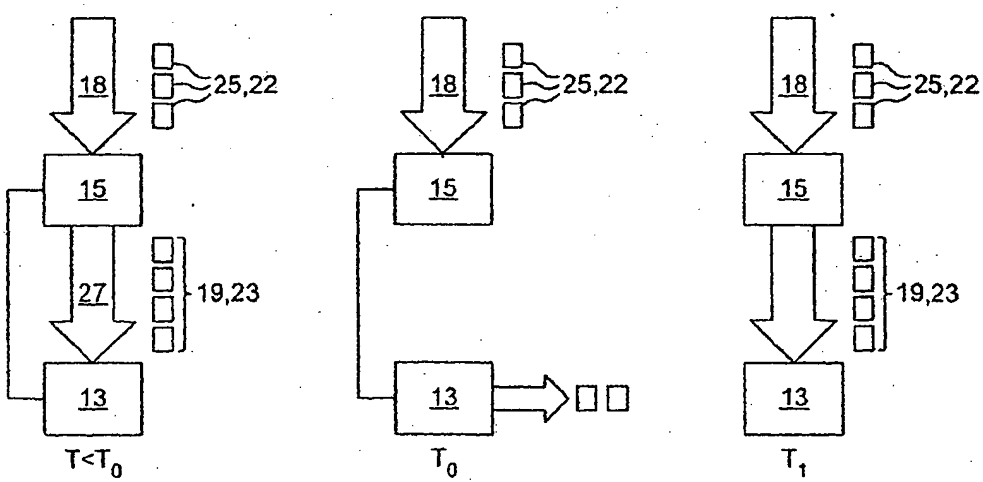

FIG. 4a FIG. 4b FIG. 4c

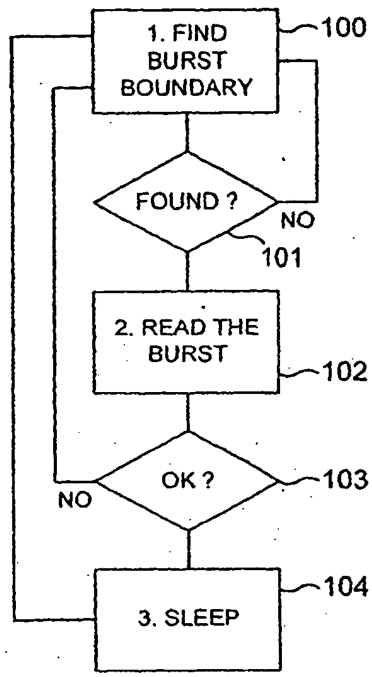
1. FIND BURST BOUNDARY
100
FOUND ?
NO
101
2. READ THE BURST
102
OK ?
NO
103
104
3. SLEEP

FIG. 5